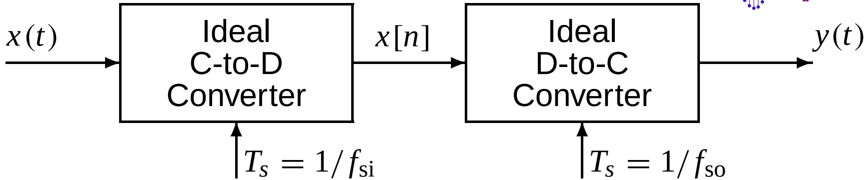
PROBLEM:



(a) Suppose that the input $x(t)$ is given by

$$x(t) = 2 + 3\cos(2\pi(2000)t - \pi/16) + 5\cos(2\pi(7000)t + 3\pi/8)$$

Determine the spectrum for $x[n]$ when $f_{\rm si} = 8000$ samples/sec. Make a $\boxed{\text{plot}}$ for your answer, making sure to label the frequency, amplitude and phase of each spectral component.

(b) Using the discrete-time spectrum from part (a), determine the analog frequency components in the output $y(t)$ when the sampling rate of the D-to-C converter is $f_{\rm so} = 8000$ Hz.

(c) Again using the discrete-time spectrum from part (b), determine the analog frequency components in the output $y(t)$ when the sampling rate of the D-to-C converter is $f_{\rm so} = 16000$ Hz. In other words, the sampling rates of the two converters are different.

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SOLUTION

(a) $x[n] = x(n/f_s)$

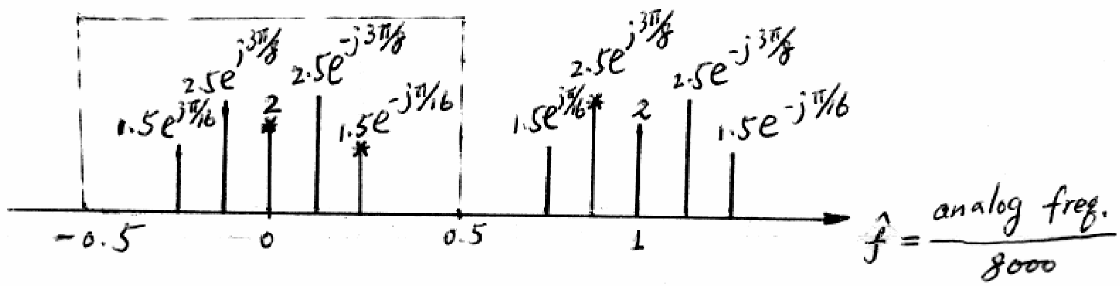
$$= 2 + 3\cos(2\pi(2000)n/8000 - \pi/16) + 5\cos(2\pi(7000)n/8000 + 3\pi/8)$$

$$= 2 + 3\cos(0.5\pi n - \pi/16) + 5\cos(1.75\pi n + 3\pi/8)$$

$$= 2 + 3\cos(0.5\pi n - \pi/16) + 5\cos(1.75\pi n - 2\pi n + 3\pi/8)$$

$$= 2 + 3\cos(0.5\pi n - \pi/16) + 5\cos(-0.25\pi n + 3\pi/8)$$

$$= 2 + 3\cos(0.5\pi n - \pi/16) + 5\cos(0.25\pi n - 3\pi/8)$$



(b) $\hat{f} = 0,\ 0.125,\ \text{and}\ 0.25, \quad f_s = 8000$

$f = \hat{f} f_s = 0,\ 1000\ \text{Hz},\ \text{and}\ 2000\ \text{Hz}$

(c) $f_s = 16000$

$f = \hat{f} f_s = 0,\ 2000\ \text{Hz},\ \text{and}\ 4000\ \text{Hz}$

McClellan, Schafer, and Yoder, *Signal Processing First*, ISBN 0-13-065562-7.
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